83-2043

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MAY 18 1984
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CLERK

Case No.

SUPREME COURT OF THE UNITED STATES

OCTOBER TERM, 1983

THOMAS A. GARDNER,

Petitioner,

vs.

TEC SYSTEMS, INC., a corporation of Wisconsin, and ROY E. DOWNHAM, JACK ECKELAERT and JOHN W. FROST,

Respondents.

APPENDIX TO PETITION FOR WRIT OF CERTIORARI TO THE UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

VOL. II

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July 1, 1969 T. A. GARDNER 3,452,447

WEB POSITIONING MEANS AND METHOD

Original Filed Sept. 23, 1963 Sheet 1 of 3

FIG. 2.

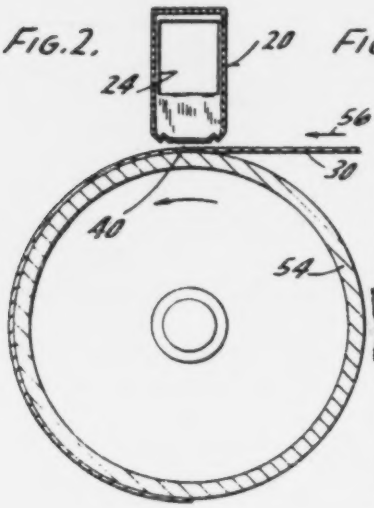


FIG. 1.

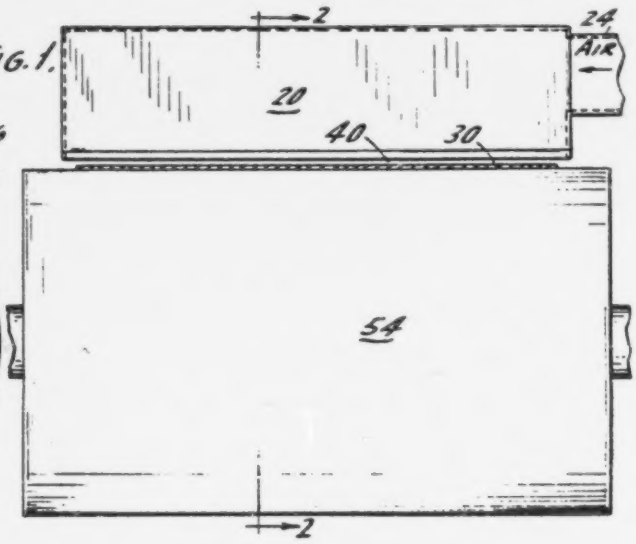


FIG. 4.

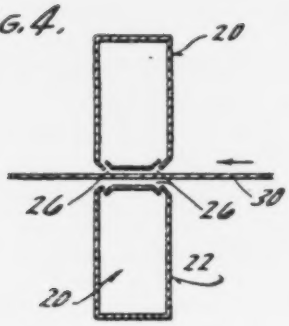


FIG. 3.

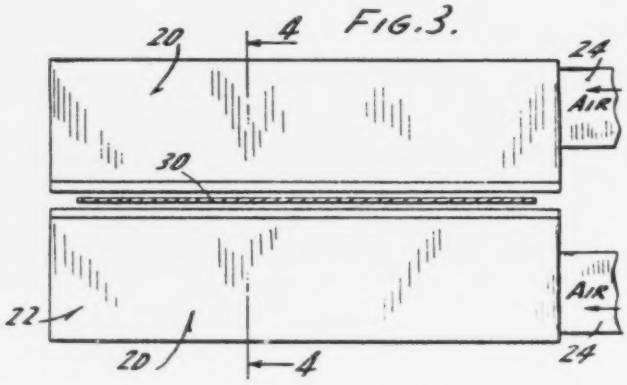


FIG. 5.

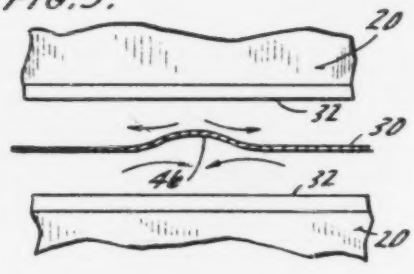
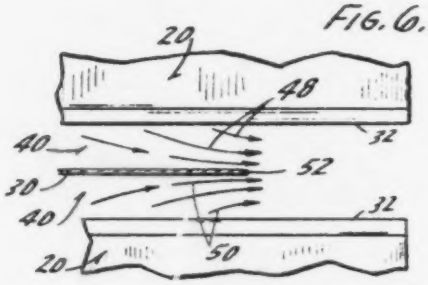


FIG. 6.



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FIG. 7.

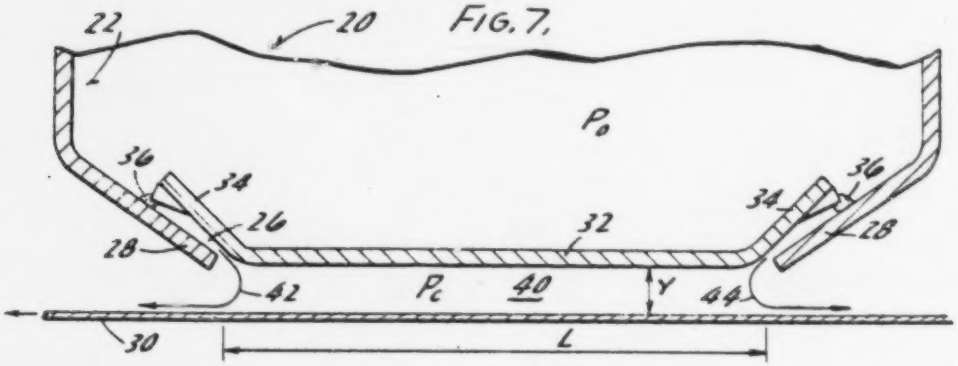


FIG. 8

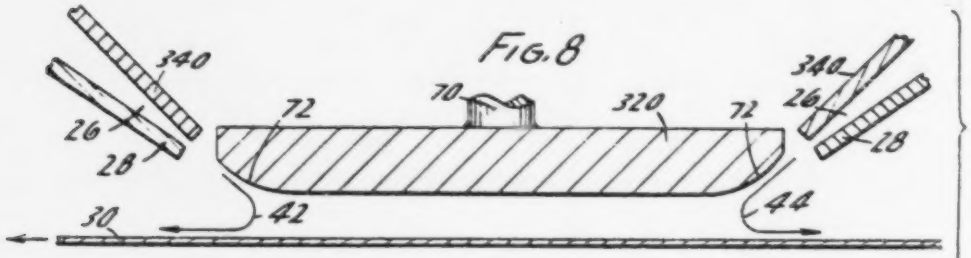


FIG. 9

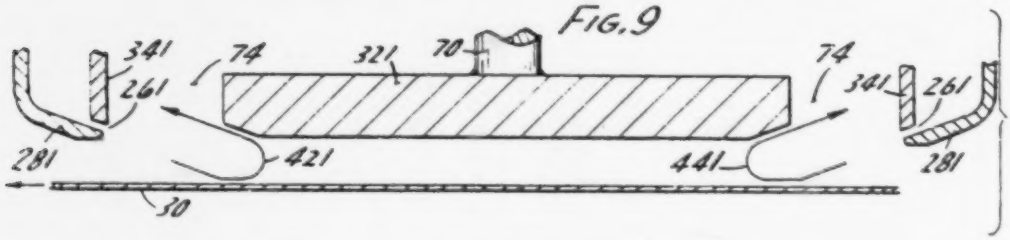
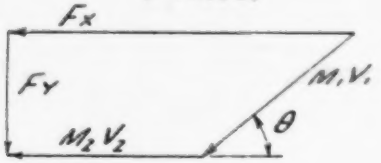


FIG. 10.



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FIG. 11.

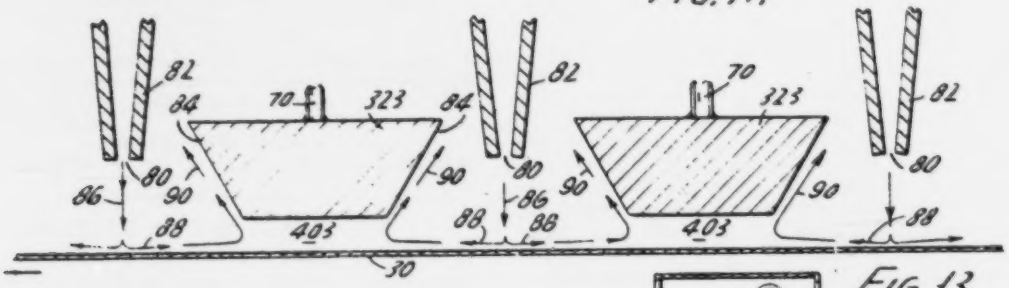


FIG. 12.

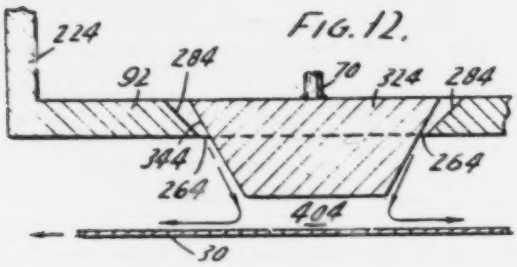


FIG. 13.

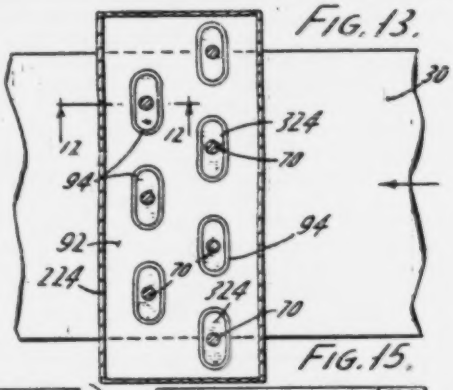


FIG. 14.

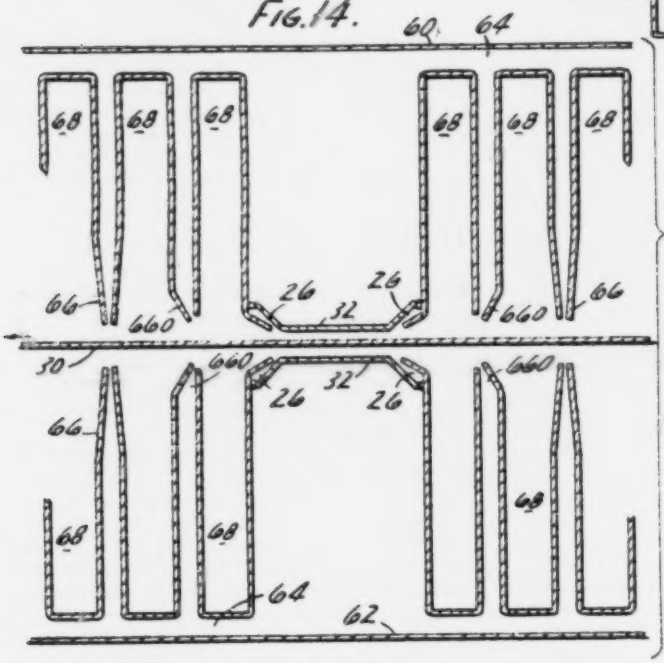


FIG. 15.

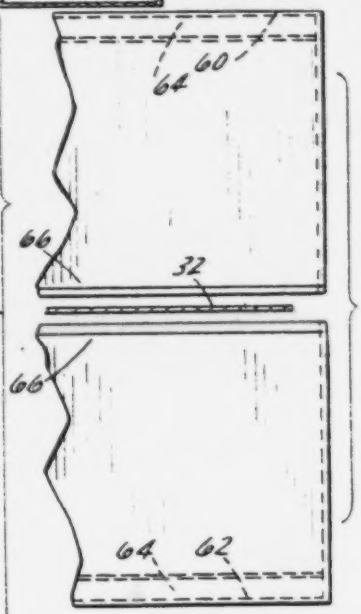
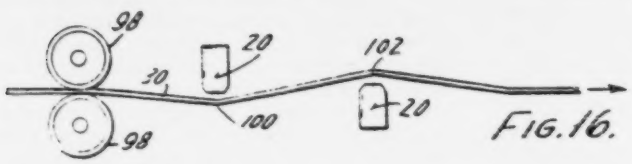


FIG. 16.



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United States Patent Office

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Patented July 1, 1969

3,452,447

WEB POSITIONING MEANS AND METHOD

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Continuation of application Ser. No. 570,671, Aug. 5, 1966, which is a continuation of application Ser. No. 310,531, Sept. 23, 1963. This application May 25, 1967, Ser. No. 641,384

Int. Cl. F26b *13/20*

U.S. Cl. 34—156 8 Claims

ABSTRACT OF THE DISCLOSURE

For positioning a moving web either in space or against a heat exchange surface, a zone of superatmospheric pressure is established by disopsing a suppression plate as close to the face of the web as is mechanically practicable and then directing between the web and plate obliquely in opposition to each other elongated jets of gas which are continuous across the web. The resultant reaction pressure develops as the gas is turned back upon itself at the edge of the pressurized zone to flow in opposite direction longitudinally of the web.

This application is a continuation of Ser. No. 570,671, filed Aug. 5, 1966, which in turn is a continuation of Ser. No. 310,531, filed Sept. 23, 1963, both now abandoned.

This invention relates to a web positioning means and method.

A major objective of the invention is to position a floating web without contacting the web with any substance but a gas, normally air. In the past, it has been proposed to support or float a web on jets of air. Mere support may be achieved through the use of the apparatus hereinafter disclosed but, in referring to the positioning as an objective of the invention, I have in mind something more than mere support, since I can accurately locate the moving web in space and also am able to hold it flat in one plane, smoothing out existing wrinkles and holding the margins in line.

In other applications of the invention, the moving web may be held in intimate contact with a surface such as that of a roll or platen, to promote heat exchange, for example. In still other applications of the invention, the web can be deflected and by deflecting it first in one direction and then in the other from its direct path, I may provide the equivalent of an accumulator to absorb momentary irregularities in feed of the web.

A basic principle of the present invention consists in the use of opposed mutually spaced air jets which are substantially continuous beside a suppression plate that intervenes between the jets, the combination of the jets and in conjunction with a suppression plate serving to create a pressure zone that subjects the web to static pressure over a large areas as distinguished from the localized kinetic effect of jets as such.

In a preferred organization, I use a structure which I characterize as a web stabilizing air bar extending transversely of the moving web for a distance at least equal to and preferably exceeding the total width thereof. The bar includes a housing which provides a plenum chamber. The structure of the bar is such that slots are continuous along the sides of the bar and direct jets convergently toward each other and toward the space between the plate and the web. The pressure zone between the jets and the suppression plate and the web is sufficintly closed so that the air of the jets is forced to change its direction and to flow in opposite directions along the face of the web away from the enclosed zone. The change in direction of momentum builds up pressure in the zone between the suppression plate and the web. Because of the large areas involved, even a small increase in pressure can provide a very considerable force acting on the web.

In the desired practice of the invention, the clearance between the suppression plate and the web is so slight that the slight loss of pressure resulting from flow out of the ends of the space does not usually detract measurably from the result. In fact, parallel flow from below and above the web laterally over the free margins at the sides of the web has very important advantages in smoothing out wrinkles or ruffles in the margin, the effect being so pronounced that manual displacement of the margins is followed by restoration of the margin to its initial position with a snap action as if the margin were subject to the action of a spring.

As will be explained, if the suppression plate is far removed from the web the effect will be lost. If the suppression plate does not extend completely across the web, the pressure zone can either be enclosed physically or the continuity of the nozzle can be extended around the end of the space to preclude loss of pressure.

In the drawings:

FIG. 1 is a view in side elevation of a roll such as a heated drying roll with which a stabilizing air bar is associated, the web being shown in section and the shaft supporting the roll being fragmentarily illustrated.

FIG. 2 is a view taken in section on the line 2—2 of FIG. 1.

FIG. 3 is a view showing in section a web floated between two stabilizing air bars in accordance with the present invention, the air bars being illustrated in side elevation.

FIG. 4 is a view taken in section on the line 4—4 of FIG. 3.

FIG. 5 is a greatly enlarged detail view showing diagrammatically the action of the air bars of FIG. 4 upon a wrinkle in an intermediate portion of the web.

FIG. 6 is a fragmentary detail view on an enlarged scale showing diagrammatically the relationship between the air bars and the margin of the floated web.

FIG. 7 is a greatly enlarged fragmentary detail view in cross section through a portion of an air bar embodying the preferred construction.

FIG. 8 is a fragmentary detail view of an air bar showing, diagrammatically, a modified construction.

FIG. 9 is a view similar to FIG. 8 showing a further modified construction.

FIG. 10 is a vector diagram.

FIG. 11 is a view similar to FIGS. 8 and 9 showing a further modified construction.

FIG. 12 is a fragmentary detail view taken in section on a greatly enlarged scale on line 12—12 of FIG. 13.

FIG. 13 is a view in horizontal section through a special form of air bar as it appears superimposed over a web which is shown in plan.

FIG. 14 is a fragmentary detail view diagrammatically showing in section a double faced dryer for a web floated therein by the incorporation of air bar structure in accordance with the invention.

FIG. 15 is an end elevation of the structure of FIG. 14, the web being shown in section.

FIG. 16 diagrammatically shows in side elevation a moving web floated between air bars so positioned as to deflect the web successively in opposite directions, thereby functioning as an accumulator to compensate for fluctuation in web movement.

The most significant uses of the invention appear to involve floating the web between air bars which are directly opposed as in FIGS. 3 to 7 and 14 and 15. However, individual air bars may be used either above or

beneath the web as exemplified in FIGS. 1, 2 and 16. In FIG. 16, the air bars are opposed, although not directly opposite. In FIGS. 8 and 9, 11, 12 and 13, it is contemplated that opposing pressure zones normally will be created by comparable opposed devices, although only one device is illustrated.

The preferred construction of an air bar 20 per FIGS. 3, 4 and 7 is as follows:

A box 22 serves as a plenum chamber supplied with air under pressure through a pipe 24. Each such box 22 preferably is elongated transversely of the web 30 to exceed the width of the web.

Extending continuously along the lower side margins of the box 22 are the nozzle slots 26, the length of which preferably exceeds the width of the web. The preferred nozzle construction is that shown in detail in FIG. 7. The flanges 28 of the side walls of box 22 are turned inwardly at approximately 45°. Extending between them in spaced relation to the work is a suppression plate 32 which defines a zone in which air under pressure acts on the web. As shown, this plate has upwardly and outwardly extending side flanges 34 which are spaced from the flanges 28 and from their free margins converge downwardly toward such flanges to define the nozzle slots 26.

The welds 36 or other means support the suppression plate 32. If the supporting means consist of welds, these are located at the rear or upper ends of the nozzles in positions such that the stream of air can re-establish its continuity before issuing from the nozzles. Any turbulence will result in loss of pressure in the pressure zone 40 between suppression plate 32 and web 30. For maximum benefit, the jets issuing from the nozzles should be continuous and as nearly as possible with uniform velocity throughout the width of web 30.

A very small percentage of the air entering the pressure zone 40 will escape from the ends of that zone across the side margins of the web 30. There is not sufficient clearance so that a very high percentage of the air can escape in this manner. Accordingly, the major portion of each jet is required to turn as indicated by the arrows at 42 and 44 so that most of the air entering the pressure zone issues from beneath the stabilizer bar in opposite directions along the face of the moving web 30. Change in direction of the momentum of the air jet is responsible for maintaing static pressure in zone 40. The mathematics will hereafter be explained.

It will, of course, be understood that while only one stabilizing bar is fragmentarily illustrated on a large scale in FIG. 7, this structure will normally be duplicated in an inverted position beneath the web as shown in FIGS. 3 to 6. Exceptions are shown in FIG. 1 and FIG. 2 and in FIG. 16 as later described.

Reference has been made to the fact that the nozzles direct the elongated jets of air substantially at 45° to the web. The angle is not critical. In general, the smaller the angle between the jet and the web, the greater will be the pressure developed in zone 40 and exerted on the web. However, it is more convenient structurally to use an angle of the approximate value of 45°. The reduction below maximum pressure is small.

I have measured the momentum of the jets flowing out of the elongated nozzles and have found that it can be expressed in the following terms:

$$MV=5.2P_oCD$$

where MV is the jet momentum in pounds for a one foot length of nozzle, C is the nozzle discharge coefficient, P_o is the pressure behind the nozzles in inches of water column, and D is the orifice width measured in feet. The forces resulting from a change in direction of momentum are vector quantities and are determined by the difference between the momentum vector of a jet as it leaves the nozzle and the momentum vector of the redirected jet. A momentum vector diagram is shown in FIG. 10 with the resultant vector forces in the horizontal and vertical directions.

I have found that the loss in momentum of the air entering and leaving the pressure zone is negligible. As a result, the two momentum vectors shown are for practical purposes both equal to the momentum of the jet leaving the nozzle. The resultant force normal to the web is, of course, resisted by the web.

The resultant forces parallel to the face of the web are of key interest. It is these forces that build up the pressure in the zone 40 and are resisted by the static pressure in that zone.

It is clear that this force acting along one linear foot of nozzle is:

$$F_x=MV(1+\text{Cos }\theta)$$

and that it is resisted by:

$$P_eY=F_x,$$

where P_e is the pressure in pounds per square foot in the space between jets, Y is the distance between the suppression plate and the web in feet, and F_x is the horizontal resultant force of the change in momentum of the jet.

If the above equations are combined to find the pressure on the web between jets, I find that:

$$P_e=\frac{5.2P_oCD(1+\cos\theta)}{Y}$$

The pressure P_e acts on the web within the area between jets so the force on the web is:

$$F_w=5.2P_oCD(1+\cos\theta)\frac{L}{Y}$$

Where F_w is the force in pounds per foot of web width, L is the length of the pressure zone as measured by the distance between jets in feet, and the other quantities are as previously defined.

In addition to the force F_w the vertical resultant vector of each of the two jets is acting on the web, but they are minor forces (usually under 10% of the total in magnitude) and are unaffected by distance of the web from the air bar. The formula therefore describes most of the design criteria for the preferred embodiments of my invention. Similar formulae can be provided for the other embodiments hereinafter disclosed.

As shown by the formulae, the scale or size of the device can be altered considerably without changing the effect. Increased pressure on the web can be secured by increasing the pressure of the air delivered into the plenum chamber, or by increasing the width of the orifice, the objective being in both instances to increase the amount of air flowing through the nozzles. The force on the web may also be increased by increasing the spacing between nozzles, thereby increasing the area of the web exposed to the pressure zone 40. There is a practical limit here in that, if the spacing becomes too large, the total cross section of the open ends of this space results in excessive loss of pressure.

Pressure on the web may further be increased by reducing the distance between the suppression plate 32 and the web. This is limited by practical considerations such as the necessity of dealing with irregularities in the web. However, as little as 3/16 inch spacing has been used successfully on paper webs.

Dimension Y should be kept as small as is practicable. As an absolute minimum, it should be somewhat larger than the nozzle orifice width D, to allow space for the jet of air to change direction and flow out of the suppression area. Experimentation indicates that the minimum dimension Y should be about twice D.

The maximum value of Y is a value at which loss of air by lateral flow across the web is still controlled. For example, in the test equipment, 0.030" nozzles spaced two inches apart were very satisfactory at a distance of 3/16 inch from the web, but began to lose control

at 0.030" from the web. It is believed, therefore, that the product of L times Y should be less than 20 times D, provided, however, that L must always be as great as Y. Accordingly, it may be said that the square of Y must be less than 20 times D.

Finally, the pressure in zone 40 may be increased by reducing the angle theta to zero as a limit. Practical considerations make it desirable to use an angle theta of approximately 45° and the advantage of reducing the angle to zero is only about 17%. If theta is greater than 90° (in other words, if the jets are divergent rather than being convergent toward the work) the cosine of the angle becomes negative with considerable loss.

The most interesting factor demonstrated by the formula is the spring effect. A given construction of my apparatus is fixed in all dimensions except Y. Clearly, if the web moves away from the air bar so that Y increases, the force on the web drops in inverse proportion. The reverse is equally true. Therefore, the action is similar to that of a compression spring. When a web is transported between two of my air bars, the effect is similar to having opposed compressing springs on opposite sides of the web. The positioning force is quite strong. If the webs handled have considerable weight (most webs have insignificant weight), periodic vibration can occur and must be eliminated by proper design.

It is possible to admit additional air to the pressure space over the web through holes in the suppressor plate. This will force more air to flow out of the pressure zone between the plate and the work and thus add to the horizontal momentum vector only. Increased pressure on the web will result, but it is much more effective if the conventional jets are increased in size, thereby increasing both momentum vectors.

The basic method of transporting a web using the preferred arrangement is to simply mount air bar units on both sides of the web in opposition to each other. Air is supplied at preferably equal pressure to both units and the web is positioned at a level midway between the units because in that position the pressure on each side of the web is equal. The pressure supplied to the units does not need to be exactly equal because the pressure on the web is a function of distance Y as well as P_0. Consequently, if more pressure is supplied to the top unit than to the bottom, the pressure above the web is greater than that below, and the web adjusts downward (which decreases the pressure above and increases the pressure below) until the pressures are balanced. This effect is more important if webs of significant weight are to be transported. In this case, higher pressure or a larger unit can be employed below the web to offset the force of gravity on the web.

As will be apparent from the foregoing, webs of widely differing weight can be positioned by use of air bars in accordance with this invention. Filmy tissue paper, or films of synthetic resin, can be held positively in a desired plane and the same is equally true of any other flexible web such as webs of heavy paper, cardboard, or sheet metal. Despite the very substantial force exerted on the web by the air in the pressure zone, damage to the work, or to coating or printing on the work surface, does not result because the invention uses primarily the static pressure over large areas rather than the kinetic energy of the jets as such.

When flexible webs are being transported, a certain amount of web tension is necessary. The flow of the redirected jets causes lift on the area of the web over which they flow, and the web tends to rise or drop on each side of the air bar. The lift forces are easily overcome by a small web tension. In practice a tension of ¼ pound per inch of web width has been successful. This is not a serious limitation, however, since most webs are transported with much more tension. For example, in offset presses the web is commonly subject to four to six pounds of tension and in paper machines the web is commonly subject to one to two pounds of tension per inch of web width.

Wrinkles in web direction are often a problem in handling flexible webs. Paper sometimes becomes wrinkled in storage and is rejected for printing purposes because of the wrinkles. Practice of the present invention tends to force wrinkles flat as shown by the detail in FIG. 5. The view is taken looking in the direction of movement of the web 30. The wrinkle 46 extends longitudinally of the web. The upward convexity of the wrinkle brings it closer to the suppression plate 32 of the upper air bar 20, thereby increasing the pressure above the wrinkle. The same convexity removes it farther from the suppression plate 32 of the lower air bar, thus decreasing the pressure below the wrinkle. In consequence, the pressure differential across the wrinkle causes the material to tend to be restored to the plane of the rest of the web.

Another problem with flexible webs concerns the tendency of edge margins to curl. FIG. 6 shows by means of the arrows at 48 and 50 the flow of air from the pressure zones 40 respectively above and below the web 30. The arrows 48 and 50 converge across the free side margin 52 of web 30. The flow is quite rapid since there is zero pressure just outside the web. The edge 52 of the web is held in the desired plane by strong resilient pressures exerted by the converging stream lines of air flow. The flow of air also exerts a slight frictional drag outwardly which further tends to spread and flatten the web. The flattening effect is so pronounced that if an operator reaches between the spaced ends of the air bars 20 and intentionally deflects the web margin 52 it will snap resiliently but strongly back to horizontal position.

The matter of holding a web tightly to a drum such as the steam cylinder 54 of a dryer has long presented problems. The web 30 moving toward the drum in the direction indicated by arrow 56 in FIG. 2 entrains air and traps this air between the web and the cylinder, thereby greatly reducing the transfer of heat. Attempts have been made to expel this air by jets directed onto the surface of the web in the direction of the roll 54 but the lift effect of the redirected jets is sufficiently great so that it tends to nullify the pressure exerted by the jets.

By using an air bar 20 constructed as above described and positioned above the line upon which the web is tangent to the drum 54, as shown in FIG. 1 and FIG. 2, I am able to hold the web very tightly against the cylinder, the pressure exerted over the relatively large area of the pressure zone 40 being so much g ater than the lift effect of the redirected jets that the latter ceases to be of any consequence.

A major use of the invention is to float and position a moving web as it passes through a dryer so that both sides of the web can be dried concurrently. This is not merely advantageous when both sides have been coated or printed. It is also advantageous whether the drying problem involves two surfaces or one surface or the body of the web. The full potential of high velocity air drying is exerted on both sides of the web at the same time. I prefer that the opposed air bars be disposed in pairs at intervals of about one and one-half feet between centers along the path of the web. The spacing is not critical. Greater spacing may be used if the web is not subject to much disturbance, or is stiff. If the web is extremely filmy, as in the case of cellophane one-half mil thick, I use air bars in pairs spaced one and one-quarter feet on center.

For drying purposes, I prefer to use the structure of FIGS. 13 and 14 which combines the air bars of the present invention with drying nozzles as disclosed in my companion application Ser. No. 80,610, filed Jan. 4, 1961, now Patent No. 3,176,412. The web 30 passes through upper and lower housings 60 and 62 each of which provides a plenum chamber 64 that supplies air both for drying and positioning the web 30. Nozzles 66 conduct the drying air in opposite directions against the opposite faces

of the web 30, being directed substantially at right angles upon the web as taught in said companion application. The spaces 68 between nozzles are vents and as many nozzles and intervening vent spaces will be used as can be accommodated between the points of positioning support which, as above noted, will normally be approximately one and one-half feet apart in the direction of web movement.

Opposing each other and provided with air from the plenum chamber 64 are the pairs of convergent nozzles 26 and the intervening suppression plates 32 to provide the pressure zones which floatingly position the web between the drying nozzles. These function as already described. However, their proper functioning inherently requires that the air escape in opposite direction along the surface of the web, whereby the momentum resulting from change in direction will maintain web positioning pressure in the pressure zone. Because the air escaping from this zone would interfere with the desired action of the drying jets 66, if not counteracted, I prefer to make the drying jets 660 which are closest to the air bars oppositely convergent toward the positioning jets as shown in FIG. 14, thus intercepting the air escaping from the positioning jets and neutralizing its movement along the web before such air passes beneath the remaining drying nozzles.

It will be apparent that considerable drying effect is attributable to the air used in positioning or stabilizing the web. It appears that for every positioning bar introduced into the dryer, the loss in drying effect is no greater than the loss of a single nozzle. This is insignificant compared to the advantages.

It is calculated that a paper mill dryer of seventy cylinders requiring some 200 lineal feet of space can be replaced by a dryer of the type shown in FIG. 13 and FIG. 14 which has a total length of only seventy feet.

In the case of drying both sides of a printed web, the saving is even more spectacular. I have used a web positioning and drying means as herein disclosed to dry ink printed on both sides of a web running at 1000 feet per minute, the over-all length of the dryer according to the present invention being only 4.2 feet as compared with fifteen to twenty feet required for the same work in competitive dryers. In addition to the speed of drying, the dryer of the present invention handles without offset a paper web freshly printed on both sides, because the instant invention makes unnecessary any physical contact with the freshly printed surfaces, the web being positioned with great accuracy between the closely proximate drying air nozzles without using any rolls or other physical guides for the purpose.

In the arrangement shown in FIG. 11, the openings 80 of the nozzles 82 are directed at right angles to the web 30 and arranged on both sides of the heavy bars 323 which serve as suppression plates and have beveled side surfaces 84. The streams of air issuing from the nozzles are normal to the work as indicated by the arrows 86 and each divides when it impinges upon the work. The components which move toward the suppression plates as indicated by arrows 88 pressurize the spaces 403 beneath these plates 323, the air then escaping upwardly and outwardly along the beveled surfaces 84 as indicated by the arrows 90.

In the construction shown in FIGS. 12 and 13, the plenum 24 has its bottom wall 92 provided at spaced intervals with symmetrically disposed openings at 94 staggered in plural rows. The openings are bordered by beveled surfaces 284 which coact with complementary beveled surfaces 344 of respective plugs 324, each of which acts as a suppression plate. The surfaces 284 and 344 converge downwardly throughout the perimeter of the suppression plate plug 324 to define continuous nozzle slots 264 in the manner clearly shown in FIG. 12. Since each slot is continuous and unbroken throughout the extent of the suppression plate, the air jet issuing therefrom confines air in the pressurized zone 404. It will be observed in FIG. 13 that the distribution of the annular nozzles and suppression plates is such that the combined effect thereof extends substantially completely across the web 30.

The construction of FIG. 8 differs from the preferred construction of FIG. 7 only in the provision of nozzle walls at 340 which are not a part of the suppression plate 320, the latter being independently supported in any desired manner, as by a suspending post at 70. The suppression plate 320 is therefore not necessarily a part of the plenum chamber, being spaced from the respective nozzles. Because the nozzles are independent thereof, the plate preferably has cylindrically rounded margins 72, the jets being directed tangentially respecting the margins 72 as indicated by the arrows 42 and 44.

In the construction of FIG. 9, the nozzle openings are defined by slots 261 between the walls 281 and 341, the direction of the jets being such that they impinge at acute angles directly on the upper surface of the work 30 as indicated by the arrows 421 and 441. The pressure in the zone between the web 30 and the lower surface of the suppression plate 321 builds up in the same manner above described, and the air escapes through the openings 74 between the suppression plate and the respective nozzles.

In the construction shown in FIG. 16, the web 30 moves from left to right through the press cylinders 98. The air bars 20 are placed at opposite sides of the web and are not only offset from each other in the direction of web travel but, as will be noted, they are offset across the plane in which the web would otherwise move from the cylinders 98. As a result, the web changes direction at 100 and 102 with somewhat the same effect as if it were passing around resiliently yieldable pulleys instead of passing the air bars 20. However, there are at least two noteworthy differences in that the web does not touch any solid surface and consequently printing or coating thereon will not be damaged even if both sides of the web are printed or coated. In the second place, since the air bars 20 provide resiliently yielding support without the inertia of mass, any increase or decrease in the tension of the web is instantly absorbed where the web changes direction at 100 and 102, thus providing the effect of an inertia-free accumulator. As soon as normal tension is restored, the web will automatically find its original position with respect to the air bars, whether the deflection has been away from or toward the air bars in response to the change in tension.

The air bars can be used for positioning a web which does not need to be dried but requires only to be conveyed over almost any distance. By simply using opposed air bars at suitable intervals along the path of the conveyor, the web will be firmly supported throughout its entire length and since the drag of the air bar is negligible, the web will have substantially constant tension throughout its length. This is not possible with roll supports because, if the web itself is relied upon to rotate the rolls this will require power, and, if the rolls are power-actuated otherwise, it is impossible to regulate the roll speeds so closely that tension variations do not occur.

Generically, the method of operation in all of the embodiments herein disclosed involves subjecting a moving web to pneumatic pressure exerted over a substantial area in which the pressure is uniform at all corresponding points longitudinally of the web. In many embodiments of the invention, the generic concept further contemplates progressive diminution of pressure toward the side margins of the web. The generic concept further contemplates that the pneumatic pressure to which the moving web is exposed shall be developed in a pressure zone into which are directed opposing jets of gas substantially continuous along opposite sides of the zone, the jets of gas escaping only after abrupt change of direction which establishes the desired static pressure as a function of

the momentum of the gas. While the kinetic energy of the gas develops the pressure, it will be observed that the surfaces of the web are exposed to very little kinetic energy of the respective jets, the desired effect being achieved by building up the pressure in zones of substantial area.

Subgenerically, the procedure involves the concept of opposing static pressure zones to which opposite faces of the moving web are exposed and between which zones the moving web is floated, any deviation from a balanced intermediate position resulting in a decrease in the pressure exerted by the gas of one zone and an increase in the other thereby restoring the web to a position in which the pressures are balanced. Particularly in regard to this subgeneric concept it is important that air be permitted to escape laterally of the web from both opposing zones. The movement of air outwardly across the margins of the web has an important effect in smoothing the ruffles and other irregularities of the web margins and stretching the margins to hold the web flat in the areas in which the zones are effective.

While all of the air introduced into the pressure zone is normally required to escape by abrupt change in direction, nevertheless there are situations in which a part of the air of the pressure zone is advantageously allowed to escape through a porous web, thus ventilating such a web. An example of the utility of this arrangement is found in the drying of water of solvents from a web, such as a paper making felt. If, for example, any one of the devices shown in FIGS. 7 to 9 or 11 to 14 is used on one side of the web only instead of being duplicated on the other side in accordance with the above described practice when the web is to be floated in an accurately predetermined position, a situation will be created in which the static pressure in the pressure zone to which the web is exposed can be used to force some of the gas in the zone through the material of the web if the web is porous. The same will obviously be true of the arrangement diagrammatically illustrated in FIG. 16, where the two air pressure bars are not directly opposite each other.

Inasmuch as the web normally has less width than the lateral extent of the opposed pressurized zones by which the web is positioned, it is entirely practicable to operate a plurality of webs side by side between the pressurized web positioned zones of opposed air bars.

I claim:

1. Means for positioning a moving web by subjecting a transverse zone spanning the web to uniform static pressure, said positioning means comprising a suppression plate extending transversely across said web and spaced therefrom as closely as is mechanically practicable, nozzle means no closer to the web than said plate and having slots which extend substantially continuously across said web and are spaced at opposite sides of said plate, the minimum spacing between the web and said plate being a distance at least approximately twice as great as the nozzle slot width, the maximum spacing of the plate from the web never being greater than the width of the plate, the product of the width of the plate and the spacing of the plate from the web being less than twenty times the nozzle slot width, and means for discharging gas under pressure through the nozzle slots for defining a zone of static pressure between the plate and the web.

2. A device according to claim 1 in which a surface on the other side of the web from said plate comprises a roll on which the other face of the web is supported, said static pressure serving to hold the web in intimate contact with the roll.

3. Web positioning means according to claim 1 in which both the plate and the nozzle slots extend laterally beyond the side margins of the web, escape of gas laterally of the web holding the web margins laterally tensioned and flat.

4. Web positioning means according to claim 1 in which the nozzle slots are so positioned angularly as to direct opposing jets of gas convergingly toward the web and into the space between the web and the plate, such space providing clearance for change in direction of the gas of said jets to move in opposite directions from a zone of static superatmospheric pressure established by the jets between the plate and the web.

5. Web positioning means according to claim 4 in which the nozzle slot positions direct the jets at angles of approximately forty-five degrees to said web.

6. Web positioning means according to claim 1 and comprising a set of air bars disposed at opposite sides of the moving web, said bars having opposed duplicate positioning structure as defined in claim 1.

7. Web positioning means according to claim 6 in which the suppression plates and nozzle slots of both bars extend beyond the side margins of the web, escape of gas from both faces of the web in directions laterally thereof holding the web margins laterally tensioned and flat.

8. Web positioning means according to claim 1 comprising air bars offset longitudinally of the web, each bar comprising positioning structure as defined in claim 1, the offset of said bars being sufficient to effect deflection of the web in passing the bars successively.

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